

SPECIAL COMMUNICATION

US patents shed light on *Eclipse* and future cigarettes

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Abstract

Objective - To define the anatomy of the *Eclipse* cigarette, and to compare the features of this smoking article with past and future low-smoke prototypes that heat instead of burn tobacco.

Design - A comparative analysis of *Eclipse* and *Premier* cigarettes was undertaken. This evaluation, and descriptions of smoking articles that have recently been awarded US patents, were used to identify emerging health, policy, and legal questions.

Results - In November 1994, the RJ Reynolds Tobacco Company (RJR) had been test marketing a low-smoke, cigarette-like, smoking article named *Eclipse* in at least eight different cities. *Eclipse* shares many of the features of *Premier*, which was introduced by RJR in 1988 and withdrawn from the market in 1990. *Eclipse* and *Premier* heat, but do not burn, the tobacco. These high technology smoking articles deliver nicotine to the user in vapour. Because the tobacco is not burned, there is reduced side-stream smoke and tar. It is not known (1) whether these new products will be able to satisfy consumers and create a market for individuals who wish to switch from conventional cigarettes; (2) what risks may be associated with their use; (3) who will test the products to ensure that the consumer is fully informed of the potential health risks.

Conclusions - The tobacco industry has spent much time, money, and effort to research and develop new smoking articles. Major changes in cigarette design have been introduced to achieve a reduction in smoke and in harmful agents generated during pyrolysis, while retaining the nicotine and flavour sought by the smoker. In these prototypes, the tobacco is not burned, an essential element in the definition of a cigarette. Accordingly, legal and regulatory policies are being challenged by those who have argued that a cigarette form has been selected for a device intended to deliver nicotine in a tobacco flavoured vapour.

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Keywords: US patents; low-smoke "cigarettes"; smoking article; nicotine; tobacco flavoured aerosol

Introduction

The RJ Reynolds Tobacco Company (RJR) recently introduced a low-smoke cigarette-like article named *Eclipse* to test panels, consisting of paid adult smokers, in at least eight different American cities (Atlanta, Buffalo, Chattanooga, Chicago, Cincinnati, Dallas, Detroit, and St Louis). The principal feature of *Eclipse* is that, unlike all other cigarettes currently marketed, the tobacco is heated and not burned.

The reasons why *Eclipse* was developed has not been disclosed by RJR; however, current wisdom would suggest that this cigarette was designed (1) to circumvent the increasing amount of legislation banning smoking in public buildings, restaurants, aeroplanes, sports stadiums, and other areas; (2) to extinguish mounting health concerns about secondhand smoke and offensive odour; (3) to reduce the pyrolysis of tobacco, which generates numerous combustion products including cancer-causing chemicals and toxic agents; and (4) to reverse falling cigarette sales in the United States. Various issues related to this \$500 million venture by RJR have been discussed in the media.¹⁻³

Presented herein is a description of the anatomy of the multiple component *Eclipse*. This smoking article delivers to the smoker a nicotine enriched and tobacco flavoured aerosol under conditions that eliminate most of the smoke, odour, stain, and ash of conventional cigarettes.

Methods

In this overview, we have used information presented in US patents that have been assigned to RJR and other tobacco companies for low-smoke cigarettes, cigarette substitutes, and related prototypes.⁴⁻¹² For more information, the reader should consult the myriad of US and foreign patents, as well as other references cited in the 1994 patents.⁸⁻¹² Also informative is the literature on the *Premier* cigarette, a predecessor of the *Eclipse* cigarette. This includes reports in a tobacco trade magazine,¹³ a clinical pharmacology journal,¹⁴ and a 744 page RJR monograph.¹⁵ The monograph addresses chemical and biological studies on the "NEW CIGARETTE" (that is, *Premier*) and other cigarette prototypes that heat instead of burn tobacco. RJR has been providing a complimentary copy of their

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monograph to interested scientists and organisations.

Results

Many US and foreign patents have been awarded for smoking articles that produce an aerosol or vapour for inhalation. An extensive listing of these patents is presented in¹⁰; also see^{4-9,11}.

A patent for a cigarette having a carbon fuel element providing the heat source for vaporising nicotine, the essential feature of the *Eclipse* cigarette, was described in a US patent awarded 36 years ago.⁴ Despite the continued widespread interest and substantial financial commitment to developing the nicotine delivery devices that mimic cigarettes, none of them has been commercially successful.^{1,2,10}

Eclipse is a smoking article, presented in a cigarette-like form, that produces a nicotine containing aerosol. The aerosol contains reduced amounts of incomplete combustion and pyrolysis products compared to those produced by a conventional cigarette. The smoke of a conventional cigarette consists of ~80% tar and related particulate materials, and ~20% water, glycerol, and nicotine. In contrast, *Eclipse* smoke is ~15% tar, and ~85% water, glycerol, and nicotine.¹ Moreover, RJR claims that *Eclipse* eliminates 85–90% of the secondhand smoke.¹

Repetitive attempts have been made to market variations of the conventional cigarette. For example, during the last 85 years, and most notably during tobacco rationed times of World War I and World War II, tobacco substitutes have been made of a variety of treated and untreated plant materials.^{15,16} These included beech leaves, dried blackberries, fermented tusilago leaves, Jerusalem artichoke, and chestnut leaves.¹⁵ Other materials that have been used or proposed include cocoa bean hulls, corn stalks, corn silk, eucalyptus leaves, lettuce leaves, sunflower leaves, rhubarb leaves, as well as products derived from wood and paper.^{10,15-17} None of these tobacco substitutes, however, has proved to be commercially successful. It is likely that the lack of commercial success attributed to the tobacco substitute products was due, at least in part, to the lack of nicotine – the addictive chemical.

The aerosols or vapours of many different tobacco substitutes have been tested and none has been found to fulfil the smoker's nicotine

requirement. In essence, these countless and repetitive endeavours have failed to establish a market for non-tobacco smoking material. Clearly, nicotine will continue to be a central facet in conventional as well as new smoking articles.

The development of various devices for generating tobacco flavoured aerosols has also been well defined in different patents. Some proposed aerosol generating smoking articles have used a heat or fuel source in order to produce a tobacco flavored aerosol. The *Premier* cigarette¹³⁻¹⁵ was introduced by RJR on 1 October 1988 and was withdrawn from the test markets on 4 April 1990.

The failure of this aerosol generating nicotine delivery device was caused by various factors. A partial listing includes poor tobacco taste, off-taste due to thermal degradation of the smoke former and flavour agents, offensive odour, hot gases that were inhaled, and unsightly appearance. The *Premier* cigarette encountered strong opposition by major public health and medical groups, which influenced public perceptions about the product and the manufacturer's unproven health claims.

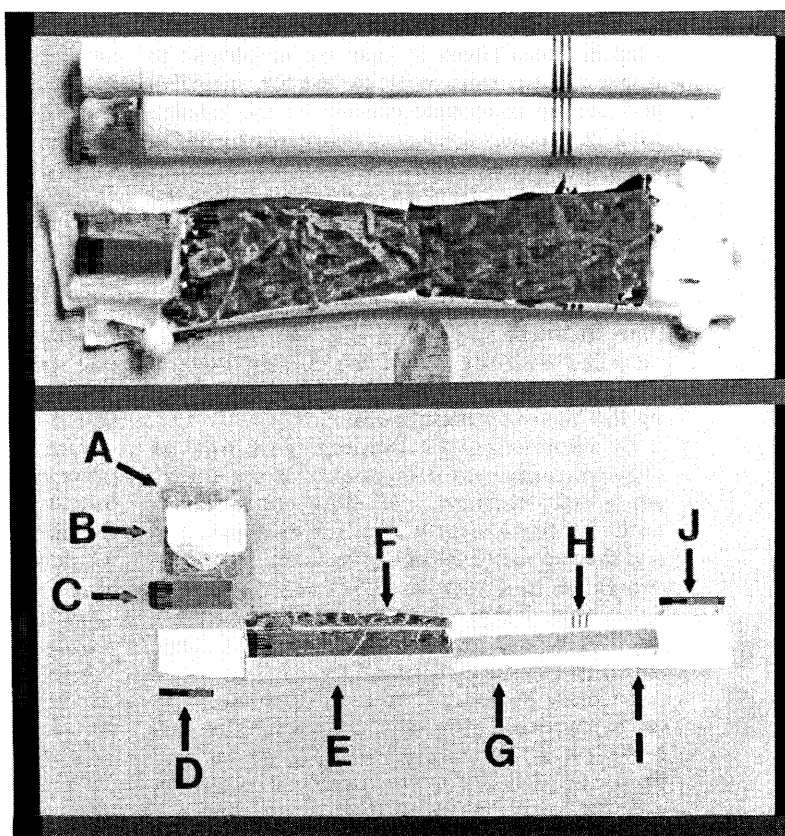
A comparison of the *Premier* and *Eclipse* cigarette is presented in the table. *Eclipse* is but one of a series of prototypes of NEW CIGARETTES (that is, *Premier*¹⁵) that heat instead of burn tobacco. A question arises as to the validity of designating these articles cigarettes. A cigarette has been defined in a 1993 US patent¹⁸ as a "charge or roll of smokable material (for example, tobacco cut filler) circumscribed by at least one layer of paper wrapping material to form a tobacco rod." Popular dictionaries offer similar descriptions. The term "smokable" and the phrase "for smoking" are essential terms in the definition. This nomenclature emphasises the fact that the tobacco is for burning, and that an aerosol is generated by tobacco combustion. By design and by performance, the tobacco in *Premier*¹⁵ and *Eclipse* is not burned and the aerosol is not generated by tobacco combustion.

Likewise, US patents, filed under the designation of "smoking articles," have been awarded for low-smoke products that are intended by the inventors to be used as cigarette-like items. However, these differ significantly from cigarettes that are marketed currently and which are sold, distributed, and smoked under the authority of existing regulations. Consequently, there exists a need to address legal, health, and policy issues related

Comparison of Premier and Eclipse cigarettes

Feature	Premier	Eclipse
1 Heats, but does not burn, tobacco	Yes	Yes
2 Carbon fuel source*	Yes	Yes
3 Glass fibres around insulator	Yes	Yes
4 Filter	Polypropylene	Cellulose acetate
5 Aluminium capsule	Yes	No
6 Alumina beads	Yes	No
7 Tobacco paper plug	Yes	No
8 Regular and menthol flavour	Yes	Yes
9 Tobacco columns	No	Yes (two)
10 Tobacco sheet around insulator	No	Yes
11 Manufacturing expense	Very high	High
12 Currently available to consumers	No	No

* Different designs used for *Premier* and *Eclipse*.



The anatomy of Eclipse (see text).

to these new smoking items that have been marketed as cigarettes.

The physical dimensions of the *Eclipse* cigarette closely approximate those of the conventional filter cigarette. With the exception of its overall appearance, all other traits of the *Eclipse* cigarette differ remarkably with other cigarettes that are marketed currently.

The anatomy of the *Eclipse* is presented in the figure. The upper panel illustrates an *Eclipse* cigarette before it had been ignited (top cigarette) and after being "smoked" completely (middle cigarette; note that the ashes are present on the tip only and that they remained attached). Also shown is an *Eclipse* cigarette that had been opened by cutting it longitudinally (bottom cigarette).

The lower panel is a view of a non-smoked *Eclipse* cigarette that had been dissected and the tobacco removed so as to illustrate the different components. The first segment (region D, ~12 mm long), readily apparent in the middle cigarette, houses the fuel element. The fuel element consists of a rod (~2 mm × 12 mm) of activated carbon (item C) that serves as the high temperature heat source for generating the aerosol. The carbon rod has five shallow, longitudinal grooves and a thin central channel. This design of the carbon rod facilitates heating the air that passes over its hot surface as one inhales each puff during the customary smoking process. The heat from this fuel source is approximately 900°C; this temperature approximates the fire cone of a conventional cigarette.^{15,19}

The fire element is wrapped in an insulating mantle of glass fibres (item B) which is

designed to prevent igniting the tobacco in the adjacent segment.

The glass fibres are wrapped in a tobacco-brown overlay (item A). This overlay is thought to be "tobacco paper", which is a softwood kraft paper containing a tobacco extract.¹⁵ This segment also contains a unique paper which displays "desirable performance attributes (for example, producing a strong, cohesive ash) during the smoking period".¹⁸

The second segment (region E, ~30 mm, which we have highlighted in the figure by adding a narrow piece of dark paper), is an aerosol generating chamber and consists of shredded reconstituted tobacco which contains more than 50 % glycerin. Aluminium foil (item F) lines the white cigarette wrapping and is used to conserve and direct the heated aerosol as it passes downstream.

The third segment (~40 mm) consists of two components. The first component (item G, ~30 mm; we have denoted this region by adding a piece of light paper), is the second of the two tobacco chambers, and contains blended tobacco. The tobacco in this compartment delivers tobacco flavour and nicotine to the heated aerosol. The second component (~10 mm; item J) houses the filter. The filter, like that of conventional cigarettes, consists of a bundle of cellulose acetate fibres. The *Eclipse* filter plug (10 mm) is considerably shorter than the filter plug (20 mm) of a standard filter cigarette.¹⁹ The conventional filter plug often begins at the designer rings (item H). Thus the position of the rings on the *Eclipse* cigarette provides the smoker with an illusion of a longer filter.

Eclipse also features a band of side ventilation holes (item I) that are employed to dilute the air, thus reducing the tar, nicotine, and carbon monoxide content of the inhaled tobacco-flavoured aerosol.¹⁹ Noteworthy, however, is the fact that the air vents of the *Eclipse* cigarette are positioned remarkably close to the end of the mouthpiece where they are likely to be blocked by the fingers or lips of the smoker. The positioning of the ventilation holes has been recognised as an industry ploy to deliver more nicotine and tar to the smoker than is recorded with the use of the current Federal Trade Commission testing method employed by the cigarette manufacturers.²⁰

By eliminating the burning (pyrolysis) of tobacco, numerous components of the smoke are greatly reduced, including chemicals in both the particulate phase (for example, tar) and the vapour phase of cigarette smoke. When compared to a standard filter cigarette, RJR states that *Eclipse* provides a significant reduction in both benzo(a)pyrene (9.2 to 0.1 ng) and nitrosamine (101 to 2.6 ng).¹

Nicotine levels in *Eclipse* approximate those of a standard ultralight cigarette.¹ In this regard, it is noteworthy that a US patent⁶ has been awarded for a non-pyrolytic cigarette, defined as a "nicotine dispensing device", which was developed to eliminate the disadvantages associated with conventional smoking of combustible cigarettes and which embodies features common to the *Eclipse* cigarette.

RJR states in a 1991 patent awarded for an *Eclipse*-like smoking article⁷ that "spray dried tobacco extract" and "tobacco extracts" can be added to the product. This and other patents imply that the nicotine content and delivery can be adjusted to achieve a desired dose of the addictive drug.

Particularly alarming is the fact that the *Eclipse* cigarette delivers approximately the same amount of carbon monoxide as a standard cigarette.¹ Carbon monoxide is a known poison, and is suspected of contributing to smoking related diseases, particularly cardiovascular diseases.²¹

The *Eclipse* cigarette is not consumed during smoking. Thus it is not surprising that difficulty has been encountered in determining when the cigarette is spent. Moreover, smokers in the test panels noted that extinguishing the *Eclipse* was difficult. As noted above, the heat from the fuel source of *Eclipse* (approximately 900°C) approximates the fire cone of a conventional cigarette.^{15,19} For these reasons, an *Eclipse* cigarette with a burning charcoal fuel element may pose an even greater fire hazard than conventional cigarettes, resulting in more casualties and greater property losses. (However, the Chairman and CEO of RJ Reynolds made this claim about *Premier*: "When it is lit and lying flat, the cigarette is also unlikely to ignite most materials - a positive step in addressing the fire safety issue regarding the careless use of cigarettes."²²)

Eclipse cigarettes generate little or no ash. The spent rods (figure: upper panel, middle cigarette) remain intact. If improperly dis-

carded, the *Eclipse* cigarettes will invariably be an even greater source of environmental pollution than the myriad of cigarette butts that now litter our streets and beaches.²³

The use of glass fibres as an insulating material may pose an additional health hazard. In a patent assigned to Philip Morris,¹⁰ Serrano *et al* note, in reference to a patent for an *Eclipse*-like cigarette assigned to Banerjee *et al* of RJR,⁵ that a resilient glass fibre insulating jacket is difficult to handle on modern mass production cigarette making machinery without special equipment. Moreover, "the glass fibres may become dislodged during shipping and migrate through the pack to rest on the mouth end of the article, giving rise to the potential for the inhalation of glass fibres into the smoker's mouth." The health hazards of the glass fibres have been addressed by RJR, which acknowledges studies in which glass fibres have been shown to induce pleural mesotheliomas in experiments of laboratory animals.¹⁵

RJR was sued recently by Schuller International Inc, a unit of the Manville Corporation, to bar its glass fibres from being used in "the manufacture of a new cigarette product for sale to the public".²⁴ In the summer of 1993, RJR asked Schuller International Inc to supply between 20000 and 50000 pounds of glass fibre to RJR by December 1993. On 3 February 1994, RJR told Schuller the project had been delayed to work out the taste and aroma problems with the proposed new cigarette design.

Schuller claimed that the fibres were to be used in RJR's pilot operations and development efforts, and that none of the glass fibres were to be used in the commercial sale of cigarettes. Arguments were also presented regarding indemnification of Schuller by RJR, which related to a proposed draft agreement for the sale of glass fibres that "... defend, indemnify and hold harmless [RJR] ... against all claims, damages, losses and expenses ... attributable to (a) bodily injury, or death, or (b) injury to or destruction of tangible property ..."

In this suit, Schuller was asking the court for a jury trial and (a) sought to show that Schuller and RJR did not reach a meeting of the minds such that an enforceable contract was retracted, and (b) requested an award to cover attorney fees and costs and all other relief that may seem appropriate. Schuller, however, withdrew the case on 5 May 1995 after reaching a settlement with RJR.²⁵

Also relevant to this case is an excellent synopsis of the mechanisms of fibre induced diseases and the role of biopersistence in the pathogenicity of manmade fibres that has recently been presented by Thomas H Hesterberg of Schuller International Inc and Roger O McClellan of the Chemical Industry Institute of Toxicology.²⁶

Discussion

Eclipse is a technologically sophisticated smoking article, and is more costly to manufacture

than conventional cigarettes being marketed today. This financial burden, as was the case with the *Premier* cigarettes, will be imposed upon the nicotine addicted smoker who, unable to quit and aware of the obvious health risks, may seek these new smoking articles because they may be perceived as safer than conventional cigarettes (see Perla *et al*, this issue, p 295).

The issue of perception also raises the question as to whether youngsters will be mislead to believe that a low-smoke cigarette is safe. This erroneous assumption may be used to challenge the advice of their parents, teachers, and health advisors. The end result could be a lifelong and costly addiction; whether the addictive drug nicotine is delivered in the form of a low-smoke or regular cigarette may prove irrelevant.

Noteworthy is that the Batelle Laboratories of Richland, Washington have been contracted by RJR to serve as an "independent" laboratory. *Eclipse* cigarettes, however, are not being made available to other groups for evaluation.

The evaluation of the *Eclipse* cigarette by different test panels has been terminated. Members of the panels found the *Eclipse* cigarette to be harder to draw than conventional filter cigarettes. In addition, difficulty was encountered in lighting the *Eclipse* cigarette. Response to the flavour and overall acceptability of the cigarette has been varied: individual responses have ranged from favourable to unacceptable.

Whether the low-smoke *Eclipse* cigarette will gain consumer acceptance remains to be determined, and RJR refuses to discuss future activities for this or related smoking devices.

To address health issues relating to carbon monoxide from the carbon fuel element, RJR has developed a tobacco smoking article with an electrochemical heat source.^{12, 27}

Philip Morris Inc have patented a cigarette similar to *Eclipse*,¹⁰ and they have also developed a cigarette that contains an electric heater for producing a flavour generated aerosol that contains very little carbon monoxide.⁸

CONCLUSIONS

Numerous patents that have been approved during the last few years document the intention of the tobacco industry to market new smoking articles. This new generation of technically sophisticated cigarettes and cigarette substitutes differs significantly from those currently being marketed. Many investigators and informed smokers believe that low-smoke prototypes are simply nicotine delivery devices.

If the US Food and Drug Administration is allowed to treat nicotine in tobacco products as a drug, it is conceivable that the manufacturers of these new smoking articles could be required to disclose to consumers information about

their health risks. Up to now, cigarette manufacturers have been free to distribute these products without regulation by the government.

All tobacco products, particularly devices that are being introduced to the market to mimic existing cigarettes, should be required to comply with regulations that have been enacted and enforced for many years to ensure the safety and efficacy of foods, drugs, and cosmetics.

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